

Separating a Mixture by Filtration

Physical and Chemical Changes

Introduction

Most of the matter around us consists of mixtures, or physical blends, of many substances. The main characteristic of a mixture is that it has a variable composition—the components of the mixture may be mixed in varying proportions. The substances in a mixture retain their distinctive chemical identities, as well as some of their unique physical properties. How are the properties and composition of a mixture affected by physical and chemical changes?

Concepts

- Mixture vs. pure substance
- Homogeneous vs. heterogeneous
- Physical and chemical changes
- Filtration

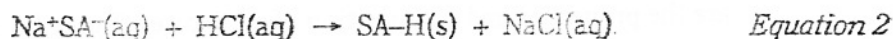
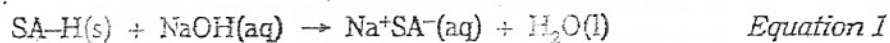
Background

Mixtures can be classified as either heterogeneous or homogeneous. A *heterogeneous mixture* is a mixture that is not uniform in composition. If one portion of the mixture were to be sampled, its composition would be different from the composition of another portion. Soil, containing bits of decayed material along with sand, silt or clay, is a heterogeneous mixture. A *homogeneous mixture* (e.g., a solution) is a mixture that has a completely uniform composition. The components of the mixture are evenly distributed throughout the sample. Air, saltwater, and brass are examples of homogeneous mixtures. Air is a gaseous solution consisting of a mixture of nitrogen, oxygen, and carbon dioxide. Saltwater is a liquid solution containing sodium chloride dissolved in water, and brass is a solid solution of two metals, copper and zinc.

Many mixtures, both homogeneous and heterogeneous, can be separated into their components using physical separation techniques such as filtration, evaporation or distillation. The properties of each component before mixing and after separation will not be altered by undergoing the physical separation. Consider, for example, a homogeneous mixture (a solution) of sugar in water. The sugar can be recovered by evaporation of the water; the water can be recovered by condensation. The sugar has the same properties before mixing and after separation. The same is true of the water.

In this experiment, the components of a mixture will be separated using a combination of chemical and physical changes. The mixture to be separated consists of charcoal, an activated form of carbon that is used to purify water, and salicylic acid, an organic compound used in drug manufacture. Activated charcoal filters are used on water faucets to make drinking water taste better, in gas masks to absorb toxic gases, and in aquarium tanks to remove chemical and biological pollutants. Salicylic acid is the parent compound of a class of drugs called the salicylates. The most important drug in this class is aspirin (acetylsalicylic acid), which is made by reacting acetic acid and salicylic acid. Salicylic acid was first isolated in nature in 1827 from the bark of the willow tree. (The curative powers of willow tree bark had been known since the times of the ancient Greeks.)

Salicylic acid is a white solid which melts at 157–159 °C. Although salicylic acid is essentially insoluble in water, it will dissolve in water containing bases, such as sodium hydroxide. Charcoal is a black solid with a very high melting point. It is completely insoluble in water and in dilute solutions of acids or bases. When salicylic acid (abbreviated SA-H) dissolves in sodium hydroxide solution (NaOH), it loses a hydrogen ion (H⁺) and is converted to an ionic form (Na⁺SA⁻) that is soluble in water (Equation 1). Adding hydrochloric acid to the resulting solution reverses the process—the SA⁻ anion picks up an H⁺ cation, reforming the neutral compound, SA-H, which then precipitates from solution (Equation 2).



Materials

Balance, centigram (0.01-g precision)	Beral-type pipets, 2
Charcoal-salicylic acid mixture, 0.6 g	Erlenmeyer flasks, 50-mL, 2
Hydrochloric acid solution, HCl, 1 M, 6 mL	Filter funnel, short stem, small
Sodium hydroxide solution, NaOH, 0.2 M, 20 mL	Filter paper, 11- or 12.5-cm, 2
Wash bottle and distilled water	Graduated cylinder, 25- or 50-mL
Ring stand and ring clamp	Magnifier
Watch glasses, 2, or paper towels	Spatula
Weighing dish	Stirring rod

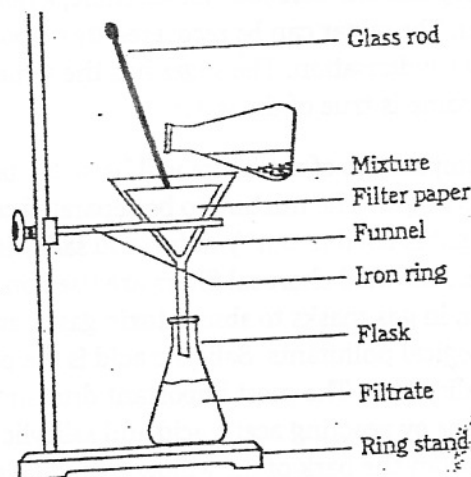


Figure 1.